12. New experiments are asked on the mode of growth of bone, of such a kind as to abolish the differences of opinion founded upon results apparently contradictory, announced in recent years by various experimenters.

13. A thorough investigation is wanted of some of the species of Linnæus, chosen from among those which present more or less of varied forms. These species ought to be wild (*spontanées*) plants, to the number of ten at least, and of twenty or more, belonging to two natural families at least, and inhabiting well-explored countries, such as Europe, the United States, &c. The author ought to discover, describe, and classify all the forms more or less distinct, and more or less hereditary, which are included in the Linnean species, being careful to intimate their habitat, their station. He ought to study their mode of fecundation, and to judge how far certain forms may be attributed to crossing. The classification of forms into species, races, varieties, and other subdivisions as may be necessary, ought to be based at once upon the external forms and on the more intimate affinities demonstrated by fecundation and grafting.

II. For competition in 1876, for which the limit is fixed on Jan. 1, 1876.

1. Exact researches are asked for concerning the dissolving power of water, and of water charged with carbonic acid, for gypsum, chalk, and dolomite, at different temperatures and pressures, and in the case of the simultaneous presence of marine salt and other common soluble salts.

2. The same is asked for silex and the most common natural silicates.

3. To submit to a new investigation the structure of the kidneys of Mammalia, specially in reference to the epithelial lining of the different parts of the renal tubes.

4. A critical examination of recent researches from which it would appear to result that the peptones of different albumenoid matters are mixtures of substances in part already known and partly yet unknown. This critical examination should be completed by personal researches.

5. To determine exactly in Weber units, the resistance of a column of mercury of one metre in length and of one square millimetre in section, at 0°.

6. To make better known, by careful experiments, the relation between the two kinds of electrical units, electro-magnetic units and electro-static units.

7. New experiments tending to determine the influence of pressure on chemical action.

The prize offered by the Society for each of these questions consists (at the choice of the competitors) either of a gold medal bearing the ordinary stamp of the Society, along with the name of the author and the date, or a sum of 150 florins. A supplementary premium of 150 florins may, moreover, be awarded if any memoir is deemed worthy of it. The memoirs sent for competition ought to be written in one of the following languages:—French, Dutch, English, Italian, Latin, or German (but not in German character). They ought to be accompanied by a sealed envelope containing the name of the author, who ought not to make himself otherwise known.

COMMON WILD FLOWERS CONSIDERED IN RELATION TO INSECTS *

At the close of the last century, Conrad Sprengel published a most valuable work on Flowers, in which he pointed out that their forms and colours, their scent, honey, and general structure, have reference to the visits of insects, which are of importance to Flowers in transferring the pollen from the stamens to the pistil. Sprengel's admirable work, however, did not attract the attention it deserved, and remained comparatively unknown until Mr. Darwin devoted himself to the subject. Our illustrious countryman was the first to perceive that insects are of importance to Flowers, not only in transferring the pollen from the stamens to the pistil, but in transferring it from the stamens of one flower to the pistil of another. Sprengel had, indeed, observed in more than one instance that this was the case; but he did not appreciate the importance of the fact. Mr. Darwin's remarkable memoir on Primula, to which I shall again have occasion to refer more than once, was published in 1862; in this treatise the importance of cross-fertilisation, as it may be called, was conclusively proved, and he has since illustrated the same rule by a number of researches on Orchids, Linum, Lythrum, and a variety of other plants. The new impulse thus given to the study of Flowers has been followed up in this country by Hooker, Ogle, Bennett, and other naturalists, and on the Continent by Axell, Delpino, Hildebrand, and especially by Dr. H. Müller, who has published an excellent work on the subject, bringing together the observations of others and adding to them an immense number of his own.

Everyone knows how important flowers are to insects; everyone knows that bees, butterflies, &c., derive the main part of their nourishment from the honey or pollen of flowers; but comparatively few are aware, on the other hand, how much the flowers themselves are dependent on insects.

Yet it is not too much to say, if flowers are very useful to insects, insects, on the other hand, are in many cases absolutely necessary to flowers; that if insects have been in some respects modified and adapted with a view to the acquirement of honey and pollen; flowers, on the other hand, owe their scent and colours, nay, their very existence in the present form, to insects. Not only have the brilliant colours, the smell, and the honey of flowers been gradually developed under the action of natural selection to encourage the visits of insects, but the very arrangement of the colours, the circular bands and radiating lines,* the form, size, and position of the petals, are arranged with reference to the visits of insects, and in such a manner as to ensure the grand object which renders these visits necessary. Thus the lines and bands by which so many flowers are ornamented have reference to the position of the honey; and it may be observed that these honey-guides are absent in night-flowers, where of course they would not show, and would therefore be useless, as, for instance, in *Lychnis vespertina*, or *Silene nutans*. Night-flowers, moreover, are generally pale; for instance, *Lychnis vespertina* is white, while *Lychnis diurna* which flowers by day is red.

That the colour of the corolla has reference to the visits of insects is well shown by the case of flowers, which—as, for instance, the ray or outside florets of *Centaurea cyanus*—have neither stamens nor pistils, and serve, therefore, exclusively to render the flower-head more conspicuous. The calyx, moreover, is usually green; but when the position of the flower is such that it is much exposed, it becomes brightly coloured, as, for instance, in the Berberry.

If it be objected to me that I am *assuming* the existence of these gradual modifications, I should reply that it is not here my purpose to discuss the doctrine of Natural Selection. I may, however, remind the reader that Mr. Darwin's theory is based on the following considerations:—1. That no two animals or plants in nature are identical in all respects. 2. That the offspring tend to inherit the peculiarities of their parents. 3. That of those which come into existence only a certain number reach maturity. 4. That those which are, on the whole, best adapted to the circumstances in which they are placed, are most likely to leave descendants.

No one of these statements is, or can be, disputed, and they seem fully to justify the conclusions which Mr. Darwin has deduced from them, though not all those which have been attributed to him by his opponents.

Now, applying these considerations to flowers, if it is an advantage to them that they should be visited by insects (and that this is so will presently be shown), then it is obvious that those flowers which, either by their larger size, or brighter colour, or sweeter scent, or greater richness in honey, are most attractive to insects, will, *ceteris paribus*, have an advantage in the struggle for existence, and be most likely to perpetuate their race.

There are, indeed, other ways in which insects may be useful to plants. Thus, a species of acacia mentioned by Mr. Belt,† if unprotected, is apt to be stripped of its leaves by a species of leaf-cutting ant, which uses the leaves, not directly for food, but, according to Mr. Belt, to grow mushrooms on.

The acacia, however, bears hollow thorns, and each leaflet produces honey in a crater-formed gland at the base, and a small, sweet, pear-shaped body at the tip. In consequence it is inhabited by myriads of a small ant, *Pseudomyrma bicolor*, which nests in the hollow thorns, and thus finds meat, drink, and lodging all provided for it. These ants are continually roaming over the plant, and constitute a most efficient bodyguard, not only driving off the leaf-cutting ants, but even in Mr. Belt's opinion rendering it less liable to be eaten by herbivorous mammalia.

* Address by Sir John Lubbock, Bart., F.R.S., at the Belfast meeting of the British Association, August 1874.

* I did not realise the importance of these guiding marks until, by experiments on bees, I saw what difficulty they experience if honey, which is put out for them, is moved even slightly from its usual place.

† F. Müller has observed similar facts in Sta. Catharina. (NATURE, vol. x. p. 102.)

We are now, however, more immediately concerned with bees and flowers.

Many flowers close their petals during rain, which is obviously an advantage, since it prevents the honey and pollen from being spoilt or washed away. Everybody, however, has observed that even in fine weather certain flowers close at particular hours. This habit of going to sleep is surely very curious. Why should flowers do so?

In animals we can understand it; they are tired and require rest. But why should flowers sleep? Why should some flowers do so and not others? Moreover, different flowers keep different hours. The daisy opens at sunrise and closes at sunset, whence its name "day's-eye." The dandelion (*Leontodon taraxacum*) is said to open at seven and close at five, *Arenaria rubra* to be open from nine to three, *Nymphæa alba* from about seven to four: The common Mouse-ear Hawkweed (*Hieracium pilosella*) is said to waken at eight and go to sleep at two; the scarlet pimpernel (*Anagallis arvensis*) to wake at seven and close soon after two; while *Trogopogon pratensis* opens at four in the morning, and closes just before twelve, whence its English name, "John go to bed at noon." Farmers' boys in some parts are said to regulate their dinner-time by it. Other flowers, on the contrary, open in the evening.

Now, it is obvious that flowers which are fertilised by night-flying insects would derive no advantage from being open by day; and, on the other hand, that those which are fertilised by bees would gain nothing by being open at night. Nay, it would be a distinct disadvantage, because it would render them liable to be robbed of their honey and pollen, by insects which are not capable of fertilising them. I would venture to suggest, then, that the closing of flowers may have reference to the habits of insects, and it may be observed also in support of this that wind-fertilised flowers never sleep; * and that some of those flowers which attract insects by smell emit their scent at particular hours: thus, *Hesperis matronalis* and *Lychnis vespertina* smell in the evening, and *Orchis bifolia* is particularly sweet at night.

I now pass to the structure and modification of flowers. A perfect flower consists of (1) an outer envelope or *calyx*, sometimes tubular, sometimes consisting of separate leaves, called *sepals*; (2) an inner envelope or *corolla*, which is generally more or less coloured, and which, like the calyx, is sometimes tubular, sometimes composed of separate leaves, called *petals*; (3) of one or more *stamens*, consisting of a stalk or *filament*, and a head or *anther*, in which the pollen is produced; and (4) a *pistil*, which is situated in the centre of the flower, and consists generally of three principal parts—one or more *carpels* at the base, each containing one or more seeds; the stalk or *style*; and thirdly the *stigma*, which in many familiar instances forms a small head at the top of the style or ovary, to which the pollen must find its way in order to fertilise the flower. In some cases the stigma is sessile. Thus it will be seen that the pistil is normally surrounded by a row of stamens, and it would seem at first sight a very simple matter that the pollen of the latter should fall on the former.

This in fact does happen in many cases, and flowers which thus fertilise themselves have evidently one great advantage—few remain sterile for want of pollen. Everyone, however, who has watched flowers and has observed how assiduously they are visited by insects, will admit that these insects must often deposit on the stigma, pollen brought from other plants, generally of the same species. For it is a remarkable fact that in most cases bees confine themselves in each journey to a single species of plant, though in the case of some very nearly allied forms this is not so; for instance, it is stated on good authority that *Ranunculus acris*, *R. repens*, and *R. bulbosus* are not distinguished by the bees, or at least are visited indifferently, as is also the case with two of the species of clover, *Trifolium fragiferum* and *T. repens*. Now, it is clear, both from the structure of flowers and also from direct experiment, that as a general rule it is an advantage to flowers to be fertilised by pollen from a different plant.

I will not now enter on the large question why this confertilisation should be an advantage; but that it is so has been clearly proved. It has long been known that hybrids between different varieties are often remarkably strong and vigorous; Kolrenter speaks with astonishment of the "*statura portentosa*" of some plants thus raised by him; indeed, says Mr. Darwin,† all experimenters have been struck with the wonderful vigour, height, size, tenacity of life, precocity, and hardiness of their hybrid productions. Mr. Darwin himself, however, was, I believe, the first to show that if a flower is fertilised by pollen from a different plant, the seedlings so produced are much stronger than if the plant is fertilised by its own pollen. I have had the advantage of seeing several of these experiments, and the difference is certainly most striking. For instance, six crossed and six self-fertilised seeds of *Ipomœa purpurea* were grown in pairs on opposite sides of the same pots; the former reached a height of 7 ft., while the others were on an average only 5 ft. 4$\frac{1}{8}$ in. The first also flowered more profusely. It is also remarkable that in some cases plants are themselves more fertile if supplied with pollen from a different flower, a different variety, and even as it would appear in some cases, as in the Passion Flower, for instance, of a different species. Nay, in some cases it would seem that pollen has no effect whatever unless transferred to a different flower. In Pulmonaria, for instance, the pollen is said to be entirely without effect on the stigma of the same plant. Fritz Muller has made a variety of experiments on this interesting subject, which seem to show that in some cases, pollen, if placed on the stigma of the same flower, has no more effect than so much inorganic dust; while, which is perhaps even more extraordinary, in others the pollen placed on the stigma of the same flower acted on it like a poison. This he observed in several species: the flower faded and fell off; the pollen masses themselves, and the stigma in contact with them, shrivelled up, turned brown, and decayed; while other flowers on the same branch, which were left unfertilised, retained their freshness.

We will now pass to the consideration of the means by which self-fertilisation is checked, and cross-impregnation is effected, in plants. In some cases the pollen is simply wind-borne, in others it is carried by insects. These are attracted partly by the pollen itself, partly by the honey; while the bright colour and the scent serve to indicate the spot where the pollen and honey can be found. The calyx, which is not generally brightly coloured, probably serves as a protection to the honey, and tends to prevent bees and other insects from obtaining access to it by force.

In many cases self-fertilisation is prevented by the separation of the stamens and pistils, either in the place they occupy, or the time of their maturity. They are frequently situated, either in different flowers of the same plant, as in Euphorbia, or in different plants, as in the Hop; in other cases, although the stamens and pistils are situated in the same flower, they do not mature at the same time, the anthers in some cases producing their pollen before the pistil is ready to receive it, as was first observed in *Epilobium angustifolium* by Sprengel, in the year 1790;* while in others the reverse is the case, and the pistil, on the contrary, comes to maturity before the pollen is formed. But even when the stamens and pistils are situated in the same flower and ripen at the same time, they are sometimes so placed that it is difficult for the pollen to reach the stigma.

Moreover, it appears that if a supply of pollen from another plant is secured, it is comparatively unimportant to exclude the pollen of the plant itself, for in such cases the latter is neutralised by the more powerful effect of the former.

It is also interesting to notice that the contrivances by which cross-fertilisation is favoured, or ensured, are probably of very different geological antiquity. Thus, as Müller has pointed out,† the special peculiarities of the Umbelliferæ and Compositæ have been inherited respectively from the ancestral forms of those orders; those of Delphinium, Aquilegia, Linaria, and Pedicularis, from the ancestral forms of the respective genera; those of *Polygonum fagopyrum*, *P. bistorta*, *Lonicera caprifolium*, &c., from the ancestors of those species; while in *Lysimachia vulgaris*, *Rhinanthus cristagalli*, *Veronica spicata*, *Euphrasia odontites*, and *E. officinalis*, we find that differences have arisen even within the limits of one and the same species.

The transference of the pollen from one flower to another, as I have already mentioned, is effected principally, either by the wind or by insects. In the former case the flower is rarely conspicuous; indeed, Mr. Darwin finds it "an invariable rule that when a flower is fertilised by the wind it never has a gaily-coloured corolla." The conifers, grasses, birches, poplars, &c., belong to this category.

In such plants a much larger quantity of pollen is required than where the fertilisation is effected by insects. Everyone has observed the showers of yellow pollen produced by the Scotch fir. Again, it is an advantage to these plants to flower before the leaves are out, because the latter would greatly interfere with

* Sprengel, "Das entdeckte Geheimniss der Natur," p. 291.
† Animals and Plants under Domestication, ch. xvii.

* "Das entdeckte Geheimniss der Natur."
† Müller, p. 44.

the access of the pollen to the female flower. Hence such plants as a rule flower early in the spring. Again, in such flowers the pollen is less adherent, so that it can easily be detached by the wind,* which would manifestly be a disadvantage in the case of most of those flowers which are fertilised by insects.

Such flowers generally have the stigma more or less branched or hairy, which evidently must tend to increase their chances of catching the pollen.

It is an almost invariable rule that wind-impregnated flowers are inconspicuous, but the reverse does not hold good, and there are many flowers which, though habitually visited by insects, are not brightly coloured. In some cases flowers make up by their numbers for the want of individual conspicuousness. In others the insects are attracted by scent; indeed, as has already been mentioned, the scent, as well as the colours of flowers, has no doubt been greatly developed through natural selection, as an attraction to insects.* But though bright colours and strong odours are sufficient to attract the attention of insects, something more is required. Flowers, however sweet smelling or beautiful, would not be visited by insects unless they had some more sub-

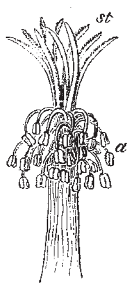

FIG. 1.

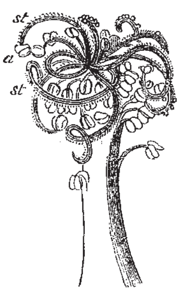

FIG. 2.

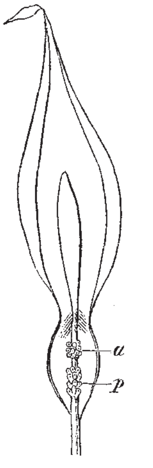

FIG. 3.

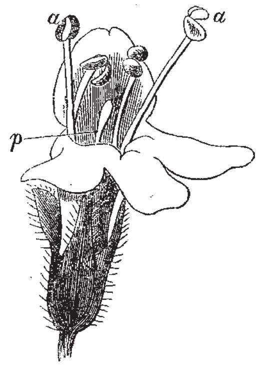

FIG. 4.

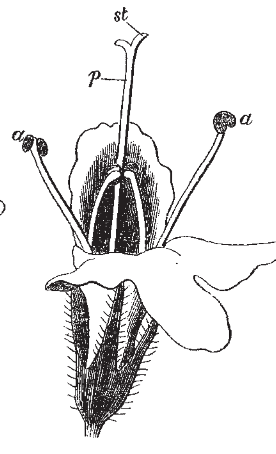

FIG. 5.

stantial advantages to offer. These advantages are the pollen and the honey; though it appears that some flowers beguile insects by holding out the expectation of honey which does not really exist, just as some animals repel their enemies by resembling other species which are either dangerous or disagreeable.

The pollen, of course, though very useful to insects, is also essential to the flower itself; but the scent and the honey, at least in their present development, are mainly useful to the plant in securing the visits of insects, and the honey also sometimes in causing the pollen to adhere to the proboscis of the insect. Among other obvious evidences that the beauty of flowers is useful in consequence of its attracting insects, we may adduce those cases in which the transference of the pollen is effected in different manners in nearly allied plants, sometimes even in different species belonging to the same genus.

Thus, *Malva sylvestris* and *Malva rotundifolia*, which grow in the same localities, and therefore must come into competition, are nevertheless nearly equally common. In both species the young flowers contain a pyramidal group of stamens which surround the as yet immature pistil, and produce a large quantity

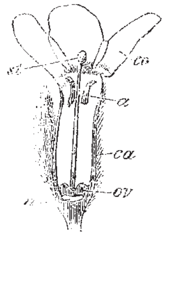

FIG. 6.

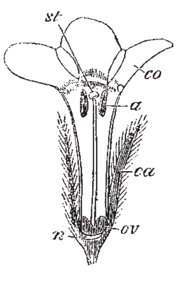

FIG. 7.

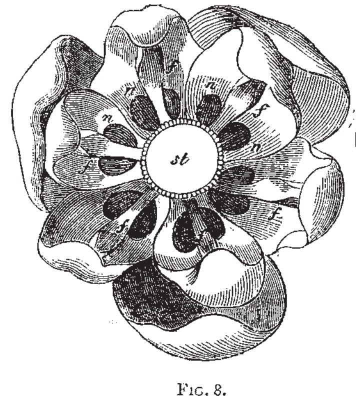

FIG. 8.

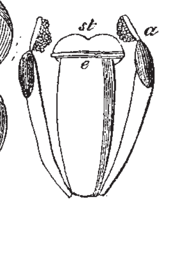

FIG. 9.

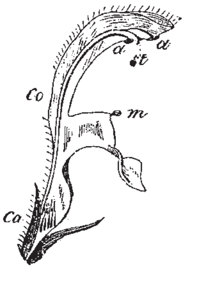

FIG. 10.

of pollen, which cannot fail to dust any insect which may visit the flower for the sake of its honey. In *Malva sylvestris* (Fig. 1), where the branches of the stigma are so arranged that the plant cannot fertilise itself, the petals are large and conspicuous, so that the plant is visited by numerous insects; while in *Malva rotundifolia* (Fig. 2), the flowers of which are comparatively small and are rarely visited by insects, the branches of the stigma are elongated and twine themselves among the stamens, so that the flower can hardly fail to fertilise itself.

Another remarkable instance occurs in the genus Epilobium, which is, moreover, specially interesting, because in *E. angustifolium*, as I have already mentioned, the curious fact was first noticed that the pistil did not mature until the stamens had shed their pollen. *E. angustifolium* has conspicuous purplish-red

* On the other hand, it is an advantage to wind-borne seeds to be somewhat tightly attached, because they are then only removed by a high wind which is capable of carrying them some distance.

* In confirmation of this it is stated that when insects are excluded, the blossoms last longer than is otherwise the case; that when flowers are once fertilised, the corolla soon drops off, its function being performed.

flowers, in long terminal racemes, and is much frequented by insects; *E. parviflorum*, on the contrary, has small solitary flowers, and is seldom visited by insects. Now, to the former species the visits of insects are necessary, since the stamens ripen before the pistil, and the flower has consequently lost the power of self-fertilisation. In the latter, on the contrary, the stamens and pistil come to maturity at the same time, and the flower habitually fertilises itself. It is, however, no doubt sometimes crossed by the agency of insects; and indeed I am disposed to believe that this is true of all flowers which are either coloured or sweet scented. The degree in which flowers are dependent on insects differs very much, and it seems to be a general rule that in any genus where the flowers differ much in size, the largest ones are specially dependent on insects.

As already mentioned, the self-fertilisation of flowers is in other cases still more effectually guarded against by the fact that the stamens and pistils do not ripen at the same time.

In some cases the pistil ripens before the stamens. Thus the Aristolochia has a flower which consists of a long tube with a narrow opening closed by stiff hairs which point backwards, so that it much resembles an ordinary eel-trap. Small flies enter the tube in search of honey, which from the direction of the hairs they can do easily, though on the other hand, from the same cause, it is impossible for them to return. Thus they are imprisoned in the flower; gradually, however, the pistil passes

FIG. 11

maturity, the stamens ripen and shed their pollen, by which the flies get thoroughly dusted. Then the hairs of the tube shrivel up and release the prisoners, which carry the pollen to another flower.

Again, in the common Arum (Fig. 3), we find a somewhat similar mode of fertilisation. The well-known green leaf encloses a central pillar which supports a number of pistils near the base, and of anthers somewhat higher. Now, in this case nothing would at first sight seem easier or more natural than that the pollen from the anthers should fall on and fertilise the pistils. This, however, is not what occurs. The pistils (*p*) mature before the anthers (*a*), and by the time the pollen is shed have become incapable of fertilisation. It is impossible, therefore, that the plant should fertilise itself. Nor can the pollen be carried by wind. When it is shed it drops to the bottom of the tube, where it is so effectually sheltered that nothing short of a hurricane could dislodge it; and although Arum is common enough, still the chances against any of the pollen so dislodged being blown into the tube of another plant would be immense.

As, however, in Aristolochia, so also in Arum, small insects which, attracted by the showy central spadix, the prospect of shelter or of honey, enter the tube while the stigmas are mature, find themselves imprisoned, as the fringe of hairs, while permitting their entrance, prevents them from returning. After a while, however, the period of maturity of the stigmas is over, and each secretes a drop of honey, thus repaying the insects for their captivity. The anthers then ripen and shed their pollen, which falls on and adheres to the insects. Then the hairs gradually shrivel up and set the insects free, carrying the pollen with them, so that those which then visit another plant can hardly fail to deposit some of it on the stigmas. Sometimes more than a hundred small flies will be found in a single Arum. In these two cases there is obviously a great advantage in the fact that the stigmas arrive at maturity before the anthers. Generally, however, the advantage is the other way, and the stamens ripen before the pistil.

Of this we may take the thyme or the marjoram as an illustration. The flowers are crowded together, and as the stigmas do not come to maturity until all the anthers in the same head have shed their pollen, it is obvious that bees creeping over the

FIG. 12.

flowers must transfer the pollen from the anthers of one head to the pistils of another.

Fig. 4 represents a flower of the thyme (*Thymus serpyllum*), and shows the four ripe stamens, and the short, as yet undeveloped pistil. Fig. 5, on the contrary, represents a somewhat older flower, in which the stamens are past maturity, while the pistil, on the other hand, is considerably elongated, and is ready for the reception of the pollen.

Here it is at once obvious that insects alighting on the younger (male) flowers would dust themselves with pollen, some of which, if they subsequently alighted on an older flower, they could not fail to deposit on the stigma. It should also be mentioned that in this genus there are likewise some small flowers which contain no stamens. In some cases flowers which are first male and then female, are male on the first day of opening, female on the second. In others the period is longer. Thus

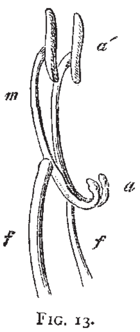

FIG. 13.

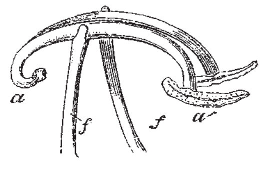

FIG. 14.

Nigella, according to Sprengel, is male for six days, after which the stigma comes to maturity and lasts for three or four.*

Fig. 6 represents a flower of *Myosotis versicolor*, a species often known as the Forget-me-not, when just opened. It will be observed that the pistil projects above the corolla and stamens, so that it must be first touched by any insect alighting on the flower. Gradually, however, the corolla elongates, carrying up the stamens with it, until at length they come opposite the stigma, as shown in Fig. 7. Thus, if the flower has not already been fertilised by insects, it is almost sure to fertilise itself.

I will now call attention in more detail to some of our common wild flowers, in order to show how beautifully they are adapted to profit by the visits of insects, and how the various parts are arranged so as to favour not only the transfer of pollen from one flower to another, but also its deposition on that part of the

* "Das entdeckte Geheimniss der Natur," p. 287.

pistil which is especially prepared for its reception. Wherever the pistil projects beyond the stamens, it is obvious that a bee alighting on the flower would come in contact first with the former and subsequently with the latter. In flying from flower to flower, therefore, she would generally fertilise each with the pollen of one which had been previously visited.

Fig. 8 represents the common Berberry. *ff* represent the stamens, which lie close to the petals and almost at right angles to the pistil (*st*), as shown in the figure. The honey-glands (*n n*) are twelve in number, situated in pairs at the base of the petals, so that the honey runs down into the angle between the bases of the stamens and of the pistil. The papillary edge of the summit of the pistil (*s t*) serves as the stigma. In open flowers of this kind it is of course obvious that insects will dust themselves with the pollen and then carry it with them to other flowers. In Berberis, however, both advantages, the dusting and the cross-fertilisation, are accomplished by a very curious contrivance. The bases of the stamens are highly irritable, and when an insect touches them the stamens spring forward (Fig. 9) and strike the insect. The effect of this is not only to shed the pollen over the insect, but also in some cases to startle it and drive it away, so that it carries the pollen, thus acquired, to another flower.

In few flowers is the adaptation of the various parts to the visits of insects more clearly and beautifully shown than in the common white Dead Nettle (*Lamium album*), Fig. 10. The honey occupies the lower contracted portion of the tube (Fig. 10, *c a*), and is protected from the rain by the arched upper lip and by a thick rim of hairs. Above the narrower lower portion the tube expands and throws out a broad lip (Fig. 10, *m*), which serves as an alighting place for large bees, while the length of the narrow tube prevents the smaller species from obtaining access to the honey, which would be injurious to the flower, as it would remove the source of attraction for the bees, without effecting the object in view. At the base of the tube, moreover, there is a ring of hairs, which prevent small insects from creeping down the tube and so getting at the honey. Lamium, in fact, like so many of our other wild flowers, is especially adapted for humble-bees. They alight on the lower lip (Fig. 10, *m*), which projects at the side so as to afford them a leverage by means of which they may press the proboscis down the tube to the honey; while on the other hand the arched upper lip, in its size, form, and position, is admirably adapted not only as a protection against rain, but also to prevent the anthers (Fig. 10, *a a*) and pistil (Fig. 10, *s t*) from yielding too easily to the pressure of the insect, and thus to ensure that it presses the pollen which it has brought from other flowers against the pistil.

The stamens do not form a ring round the pistil, as is so usual. On the contrary, one stamen is absent or rudimentary, while the other four lie along the outer arch of the flower, on each side of the pistil. They are not of equal length, as is usual, but one pair is shorter than the other; sometimes the inner pair, and at others the outer pair being the longest. Now, why is this? Probably, as Dr. Ogle has suggested, because if the anthers had lain side by side, the pollen would have adhered to parts of the bee's head which do not come in contact with the stigma, and would therefore have been wasted; perhaps also partly, as he suggests, because it would have been deposited on the eyes of the bees, and might have so greatly inconvenienced them as to deter them from visiting the flower. Dr. Ogle's opinion is strengthened by the fact that there are some species, as for instance the Foxglove, in which the anthers are transverse when immature, but become longitudinal as they ripen.

But to return to the Dead Nettle. From the position of the pistil which hangs down below the anthers, the bee comes in contact with the former before touching the latter, and consequently generally deposits upon the stigma pollen from another flower. The small processes (Fig. 10, *m*) on each side of the lower lip are the rudiments of the lateral leaves with which the ancestors of the Lamium were provided. Thus, then, we see how every part of this flower, is either, like the size and shape of the arched upper lip, the relative position of the pistil and anthers, the length and narrowness of the tube, the size and position of the lower lip, the ring of hairs and the honey, adapted to ensure the transference, by bees, of pollen from one flower to another; or, like the minute lateral points, is an inheritance from more highly developed organs of ancestors. If we compare Lamium with other flowers we shall see how great a saving is effected by this beautiful adaptation. The stamens are reduced to four, the stigma almost to a point; how great a contrast with the pines and their clouds of pollen; or even with such a flower as the Nymphæa, where the visits of insects are secured, but the transference of the pollen to the stigma is, so to say, accidental. Yet the fertilisation of Lamium is not less effectually secured than in either of these.

In this flower it would appear, as already mentioned, that the pistil matures as early as the stamens, and that cross-fertilisation is obtained by the relative position of the stigma, which, as will be seen in the figure, hangs down below the stamens, so that a bee bearing pollen on its back from a previous visit to another flower would touch the pistil and transfer to it some of this pollen before coming in contact with the stamens.

In other species belonging to the same great group (Labiatæ) the same object is secured by the fact that the stamens come to maturity before the pistils have shed their pollen, and shrivelled up before the stigma is mature.

Fig. 11 represents a young flower of *Salvia officinalis** in which the stamens (*a*) are mature, but not the pistil (*p*), which moreover from its position is untouched by bees visiting the flower. The anthers as they shed their pollen gradually shrivel up; while on the other hand the pistil increases in length and curves downwards, until it assumes such a position that it must come in contact with any bee visiting the flower, and would touch just that part of the back on which pollen would be deposited by a younger flower. In this manner self-fertilisation is effectually provided against. There are, however, several other points in which *S. officinalis* differs greatly from the species last described.

The general form of the flower indeed is very similar. We find again, as generally in the Labiates, the corolla has the lower lip adapted as an alighting board for insects, while the arched upper lip covers and protects the stamens and pistils.

In the present species, however, the back of the upper lip shows a deep arch at the part *x*, and the front portion of the lip, containing the stamens, is loftier than in Lamium, and does not therefore come in contact with the back of the bee. In evident correlation with this arrangement we find a very remarkable difference in the stamens (Figs. 13 and 14). Two of the stamens are minute and rudimentary. In the other pair the two anther cells (Fig. 14, *a a*), instead of being as usual close together, are separated by a long connection. Moreover, the lower anther cell contains very little pollen, sometimes indeed none at all. This portion of the stamen, as shown in Fig. 13, hangs down and partially stops up the mouth of the corolla tube. When, however, a bee thrusts its head into the tube in search of the honey, this part of the stamen is pushed into the arch, the connectives of the two large stamens revolve on their axis, and consequently the fertile anther cells are brought down on to the back of the bee, as shown in Fig. 12.

(*To be continued.*)

NOTES

THE German Government has determined upon the erection of a Sun Observatory ("*Sonnen-Warte*") upon a large scale at Potsdam. Drs. Spoerer and Vogel have already been appointed to undertake the telescopic and spectroscopic observations, and the directorship has been offered to Prof. Kirchhoff, who, however, has declined it, as he is unwilling to leave Heidelberg.

THE International Congress of Orientalists was opened in London on Monday, by an address from Dr. Birch. We hope to give an account of the proceedings in our next number.

WE are glad to see that a contemporary not specially devoted to science—the *Morning Post*—in an article on Dr. Hooker's address at Belfast, points out to its readers that the majority of the observations referred to could be made "by any intelligent person without any scientific training," and expresses a hope that "people who have the opportunities for cultivating, and leisure for observing, will make collections of plants . . . . and add to our stock of knowledge." At the same time it suggested these as interesting subjects for observation:—"How much can plants eat in twenty-four hours? When do they eat most? Under what conditions of weather? &c. Indeed, the whole field is one that

* The *Popular Science Review* for July 1869 contains a very clear and interesting paper by Dr. Ogle on this genus.